(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 January 2005 (13.01.2005)

PCT

(10) International Publication Number
WO 2005/003509 A1

(51) International Patent Classification[7]: E21B 41/00, 43/30

(21) International Application Number: PCT/GB2003/002809

(22) International Filing Date: 30 June 2003 (30.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **PETROLEO BRASILEIRO S A-PETROBRAS** [BR/BR]; Avenida Republica de Chile No. 65, CEP-20035-900 Rio de Janeiro, RJ (BR).

(71) Applicant *(for MW only)*: **BENSON, John, Everett** [GB/GB]; J A Kemp & C0, 14 South Square, Gray's Inn, London WC1R 5JJ (GB).

(72) Inventors: **LIMA, Paulo, Cesar, Ribeiro**; SQSW-Quadra 103, Bloco F, apt. 301, Sector Sudoeste, CEP 70670-306 Brasilia, DF (BR). **DE OLIVEIRA, Jose, Eduardo**; Rue Visconde de Santa Isabel, 632- Grajau, CEP 20560-121 Roi de Janeiro, RJ (BR). **DE SOUZA, Arlindo, Antonio**; Rua Lauro Müller, 86, Apt 408, Botafogo, CEP 22290-160 Rio de Janeiro, RJ (BR). **DE PAIVA, Eliran**; Rua João Celso Filho, 2575 - Lagoa Nova, CEP 59064-320 Natal, RN (BR). **ALVES, Iberé, Nascentes**; Rua Procurador Machado Guimarães, 570 - Barra da Tijuca, CEP 22793-320 Rio de Janeiro, RJ (BR). **MOREIRAS, José, Ramon, Figueiras**; Rua Cipriano Goncalves, 645-Miguel Pereira, CEP 26900-000 Rio de Janeiro, RJ (BR).

(74) Agents: **ROBERTS, Mark, Peter** et al.; J.A. Kemp & Co., 14 South Square, Gray's Inn, London WC1R 5JJ (GB).

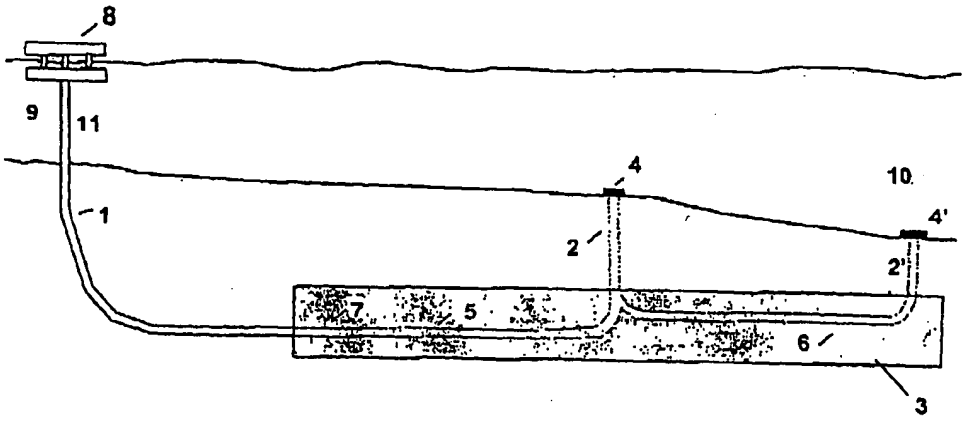
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD FOR, AND THE CONSTRUCTION OF, A LONG-DISTANCE WELL FOR THE PRODUCTION, TRANSPORT, STORAGE AND EXPLOITATION OF MINERAL LAYERS AND FLUIDS



(57) Abstract: A method is described for the construction of an arrangement of Extended Reach Wells (ERW) for the production, transport, and exploitation of mineral layers, in that an offshore reservoir of fluids (3) is initially penetrated by an initial well (1), followed by penetration by a multilateral well (2), close to or connected at the end of the drilling section (5) of the multilateral well (2) to the end of the drilling section (7) of the initial well (1). A well of long distance is therefore formed, connected hydraulically at one end (6) of the multilateral well (2) to end (7) of the initial well and to the production unit (8). The resulting long-distance well allows for the drainage of the reservoir in deep and extremely deep water (10) from a platform in shallower water (9).

WO 2005/003509 A1

METHOD FOR, AND THE CONSTRUCTION OF, A LONG-DISTANCE WELL FOR THE PRODUCTION, TRANSPORT, STORAGE AND EXPLOITATION OF MINERAL LAYERS AND FLUIDS.

FIELD OF THE INVENTION

The present invention relates to a method for the construction of an arrangement for Extended Reach Wells (ERW) for the production, transport, and exploitation of mineral layers, a well arrangement constructed in this manner, and a method for the construction of a network of ducts for the transport and storage of fluids. More specifically, the present invention relates to a method for the production of oil and gas, a method for the transport and storage of the oil and gas thus produced, a method for the drilling of long-distance petroleum and gas wells, and a method for the exploitation of reservoirs of petroleum and gas.

The present invention relates to a method of drilling and exploitation, production, transport and storage which includes the initial drilling of a well of medium distance and at least one multilateral well of medium distance in the initial direction of drilling, and in at least one direction of the reserve which it is intended to use for production. The method allows for very distant areas of the reserve to be reached, this being achieved with the aid of conventional technologies and at low cost. The method is applied principally in extremely deep water as well as in land areas with difficult access.

BACKGROUND TO THE INVENTION

Long-distance wells have long been used extensively in industry. In the past few years these wells have become viable for the exploitation of fields, extending the service lives of some and increasing the reserves available. Nevertheless, the applications of long-distance wells are limited by prohibitive costs resulting from the specifications for the drilling probes and other problems of a technical nature,

as well as the precarious remote control, excessive torque and pull, difficult cleaning from the well hole in long sections with high inclination angles, insufficient weight on the drill bit, and environmental considerations. However, applications for long-distance wells need not be limited solely to the area of production, but can also be applied to the sector of transport by pipeline, in which long-distance wells connected in series can be constructed for the transport of gases and/or liquids.

Current technology of long-distance wells is based on a single well, with considerable problems in access to remote areas due to the long distance from one single well. On the other hand, current technology in deep water consists of installing a floating production unit in waters of lesser depth and the use of wells of wet design and underwater manifolds, combined with flexible lines of very high cost as well as long-distance wells. There are, however, financial and technical limitations on this distance.

There are also serious problems with flowing via flexible lines due to the low temperature of the water at the bottom of the sea where the flexible lines are located. Long flexible lines are subject to problems of high viscosity of the fluid, the depositing of paraffin, and the formation of hydrates, as a consequence of the low temperature and high pressure. Technologies which make long-distance operation possible can reduce the length of flexible lines and even do away with them altogether, passing the fluids produced to be discharged for preference inside the well and in heated areas.

US patent No.s 5,735,350, 6,158,531 and 6,263,987B1, the disclosure of which is hereby incorporated by reference, relate respectively to drilling and completion with the use of conventional casing and in one stage, with the actual drilling column being used as the casing for vertical and lateral wells for long-distance production. The focus of these patents is the simultaneous performance of the drilling and completion of a petroleum and gas well. No provision is made for the production

of oil and gas without casing for the well. The technology described is applied principally to wells drilled on the Continental shelf.

On the other hand, current drilling processes include the drilling of a principal well or principal direction, and other multilateral wells for the exploitation of the field. This involves the completion of a number of drilled wells, activities which are both slow and burdensome.

US patent No.s 5,551,521 and 5,894,897, the disclosure of which is hereby incorporated by reference, relate to methods and equipment for cementing a drilling column in the location of the well in order to drill and complete oil and gas wells simultaneously. The object of these publications is the cementing of the drilling column as a casing for the well.

However, the patent literature relating to vertical wells or drilling processes invariably involves the completion of the drilled wells or only the drilling of the petroleum and gas production well.

On the other hand, patents relating to multilateral wells likewise relate to the completion of the drilling work.

The transport of petroleum and gas produced in multilateral land-based wells is carried out in conventional pipelines, this being a process entirely within the public domain. The transport of petroleum and gas produced in underwater multilateral wells is limited by the difficulties incurred by deposits of paraffin and the formation of gas hydrates on the pipe walls, brought about over long distances in deep water at low temperature. Technical proposals have been made for avoiding paraffination and the formation of hydrates, as well as the thermal insulation of the flexible pipes which transport the petroleum, but the solutions proposed normally involve a greater or lesser increase in costs.

US patent No.s 4,660,606 and 4,556,343, the disclosure of which is hereby incorporated by reference, describe a method and an offshore installation intended to receive, store, and transfer crude petroleum from at least one well located on the seabed. These patents make provision for the use of pipes which are suitable for the transport of oil between the production wellheads and the pipe which collects the oil from various different wells and conveys it to the installation forming the object of the patent. The pipes start from the seabed and, depending on the size of the production field and the scale of the installations to be used, may have to cover considerable distances over the seabed until reaching the installations with which they are to be integrated.

US patent No.s 4,770,199 and 4,781,207 the disclosure of which is hereby incorporated by reference, relate respectively to a method for the transporting of heavy oils and a method for transporting viscous heavy oils, in which an emulsion of the oil in water containing an organic emulsifying compound is transported and subsequently separated again into crude oil and water. These patents say nothing about the physical means by which the transport of the emulsion of oil in water is carried out, and still less about the chemical aspects involved.

US patent RE28978, the disclosure of which is hereby incorporated by reference, describes an underwater system for the production and transport of fluid minerals, which includes a collection network for the product provided with production satellites in which the gas-oil-water ratio from each well is periodically tested and the flow rate automatically controlled, and the fluids of which are transported through individual pipes to the underwater product collection stations, and then as far as the surface though rigid pipes amounting to half the mass of the seawater. In the event of excessive pressure arising in the pipe which transports the fluid from the seabed to the surface, this system makes provision for a section of the pipe to be an escape section, which would break, and around which the fluid would be collected in an inverted funnel, so restricting losses of fluid to a minimum.

US patent No 5,1547,41 the disclosure of which is hereby incorporated by reference, describes a system for the production and transport of oil and gas in deep water, including a wet "Christmas tree", a vertical two-phase oil and gas separator, a gas cooler, a vertical tubular scrubber, a motorised pump, and a platform on which a speed variator for the motorised pump is located, a pressure relief valve to provide simultaneous control on the gas pipe, the scrubber, the two-phase separator, and a programmable logic controller. The passage of the fluids between the production wellhead and the Christmas tree makes provision for the use of at least one pipe running on the seabed. The passage of the oil and gas on the basis of the system described in this patent as far as the production plant makes provision for equipment for artificial elevation, and is carried out via a separate oil pipe and gas pipe, running on the seabed and crossing the seawater mass as far as an offshore platform situated on the surface.

As can be seen, all the patents referred to make provision for at least one pipe extending over the seabed in half the fluid mass, for the transport of the fluids produced by the wells as far as a specific underwater installation, from which the fluids are conducted by at least one further pipe as far as the production installations located on the surface.

In addition to the difficulties encountered with the depositing of paraffin and the formation of gas hydrates on the inside walls of the pipes which run long distances in deep water at low temperature, there is also an increased risk of leaks of the fluids and the pollution of the surrounding environment through which the pipes run, which increase in proportion to the quantity and length of the pipes used in the transport of the fluids.

Another disadvantage of the processes and methods of the prior art is that they all require the use of various items of equipment and accessories for transporting the fluids from the underwater petroleum fields, in quantities which are proportional to

the number of petroleum and gas wells in the production group: wellhead equipment, Christmas trees, manifolds, well production lines, risers, gas pipes, oil pipes, and separators, all of which incur increased costs for installation and maintenance.

Another aspect is that the current petroleum production systems in deep water necessarily involve the continuous use of production platforms, with the high costs which these incur. It is normally necessary to make use of a number of platforms, depending on the depth of the water in which the wells being drilled are located. The principal patents for underwater production of oil and gas are analyzed hereinafter.

US patent No 5,899,637, the disclosure of which is hereby incorporated by reference, describes offshore production and storage equipment for petroleum and the respective method of installation in which the oil is produced and stored in tanks fixed to the deck of a concrete raft which is towed and submerged by the use of seawater as ballast, and kept on the seabed close to the oil production site. The oil is removed from the submerged tanks by a tanker vessel by the introduction of seawater into the submerged tanks. This patent presupposes the use of at least one additional pipe for moving the oil from the production station or from the collecting point located on the surface to the submerged tanks, with all the disadvantages already known, deriving from this being conveyed at the low temperatures of the water at the bottom of the sea (paraffin deposits on the interior of the pipe and the formation of hydrates). In addition to this, additional costs are incurred by the equipment characteristically used in this method (concrete raft, tanks, additional production and water lines) and the respective associated services (tug, ballasting and submerging the raft and tanks, the introduction of water into the submerged tanks, the installations, the control systems, and so on).

US patent No 5,330,293, the disclosure of which is hereby incorporated by reference, describes a system for the production and storage of petroleum, comprising the use of a large platform on tensioned legs in which a number of "risers" are used, which allow for freedom of vertical movement, and which therefore involve additional special structural requirements for floatability and arrangements to provide adequate support, restricting lateral movement but without the very high additional loads being applied to the platform.. With the use of the "risers" this undoubtedly will incur substantially greater costs than those involved with the technique described and claimed in this present patent. US patent no.s 5,439,321, 4,913,238, and 4,556,340, the disclosure of which is hereby incorporated by reference, envisage hydrocarbon production systems which make use of floating structures, associated or not with tensioned-leg platforms, with the sheltered production deck being free to carry out vertical movements ("heave") close to the surface, and being equipped with wellhead equipment which is connected or not by flexible risers to underwater wells. In this way, in all the patents cited in this paragraph, the production from each underwater well is processed individually, always requiring production lines, wellhead equipment, and risers; essentially, all the normal individual items of equipment for each well, which incurs a multiplication of the costs for the production equipment. There are also disadvantages associated with conveying through different pipes at low temperatures through water on the seabed (depositing of paraffin on the inside of the pipes, formation of hydrates), which multiply at least proportionally as a function of the quantity and length of the pipes used, such disadvantages being minimised by the process according to the invention described hereinafter.

US patent No 4,653,960, the disclosure of which is hereby incorporated by reference, makes provision for a crude oil separator and an offshore submersible storage apparatus which can also form a stable platform, in that an offshore structure or vessel for the drilling and production of petroleum products can be placed in position in a removable manner. This patent makes provision principally for the separation of crude oil and its storage, with the apparatus, being movable,

also being capable of serving as a mode of transport for the products in the storage containers to another maritime installation for processing the petroleum produced.

US patent No 4,452,312, the disclosure of which is hereby incorporated by reference, describes a modular underwater oil production plant having at least one satellite unit, the product of which is conducted via a collector pipe to a central structure in which operational modules are grouped. Provision is made for the use of production heads and "templates", and the installation of the production plant in excavations made on the seabed, with all the costs which the equipment and services associated with this will certainly incur.

US patent No 4,273,066, the disclosure of which is hereby incorporated by reference, envisages a method for the release of oil from an offshore well to the coast, comprising supply stretches for the oil from the well to a floating storage vessel stationed close to the well, and the transfer of the oil by means of a flexible pipe from the floating storage vessel to a service petroleum vessel which runs between the coast and the floating storage vessel. This patent makes provision for at least two lines for the passage of the fluids, one between the well and the floating storage vessel and the other between the latter and the service vessel, incurring the disadvantages of the formation of paraffin and hydrates in the submerged lines at low temperatures and high pressures, with the additional costs of the transport of the products via the petroleum vessel to the coast.

US patent No 4,152,088, the disclosure of which is hereby incorporated by reference, comprises offshore petroleum field production equipment with a production platform anchored to the seabed at the drilling site. It comprises a pivoted column connected by means of a universal Cardan coupling joint to a base anchored on the seabed, in connection with a floating gas burner located remotely for burning off the gas extracted from the oil. The production equipment items of

the underwater wells are individual items, and the system makes provision for production lines and gas lines to the burner running over the seabed.

US patent No 4,762,180, the disclosure of which is hereby incorporated by reference, provides for a modular completion system close to the surface, which positions the production heads of the wells in a calm area beneath any significant wave activity, but within the operational range of divers for maintenance and inspection, in which each underwater well is provided with its own "riser", a tensioning buoy on the riser, and a production well tree mounted on top of the riser buoy. The fluids produced are passed from the well tree to the floating production platform by means of flexible risers suspended in a catenary curve of sufficient length as to allow the platform to be manoeuvred so as to be positioned for drilling or workover of any of the various templates which it serves.

US patent No 4,211,281, the disclosure of which is hereby incorporated by reference, envisages a multiple-articulated well production system in deep water for the handling of fluids produced from a number of individual wells drilled in deep water in different parts of a field, and the conveying of the fluids from the production wells to a surface production platform by means of a central riser.

US patent No.s 5,255,744 and 5,341,884, the disclosure of which is hereby incorporated by reference, envisage an underwater production system and methods for the connection of pipes in a "manifold", and adjacent satellite wells in which the satellites are connected to the manifold via production pipes which run at a distance between each satellite well and the manifold, supported on the seabed and with half the mass of seawater.

As can be seen, the petroleum production systems in deep water which currently exist make use of individual items of equipment and individual production pipes for each well, associated with the manifolds or Christmas trees which collect the fluids produced from the various different wells and transfer them to additional lines

which, in turn, travel via the production risers to the surface platforms equipped with petroleum production plant.

The different depths of the sea in which the wells concerned are located also require that the load losses due to the flow in the production lines be kept to a minimum in order to optimise the production from the wells, impose the use of more than one production platform per production field, and so substantially increase the costs of production and maintenance of the equipment, as well as the other individual costs of the equipment per well and those of the production pipes laid on the seabed, individual wellheads, manifolds, and "Christmas trees".

Another disadvantage of these systems is associated with the exposure of the large number of different items of equipment of the wellheads, Christmas trees, manifolds, pipes, lines, collector stations, satellites, risers, and the fluids which circulate within them, to the adverse conditions of high pressure and low temperature present during the movement, consequently resulting in the depositing of paraffin inside the pipes and the formation of hydrates, which in the future will require cleaning operations, maintenance, or even the repositioning of the equipment and pipes at extra cost which will undoubtedly be substantial.

In addition, in order for the pipes to be grouped together for production, individual completion services will be required, which incur the costs of the immobilisation and movement of the platforms, incurring heavy operational, service, and maintenance costs, in addition to the other well operations inherent in completion which precede the commissioning of these pipes, and the time taken (down-time) inherent in the other actions involved in completion services.

Accordingly, all the patent literature relating to the drilling of petroleum and gas wells stipulates that these must invariably be provided with casing, up to the actual drill pipe itself, such as in US patent No 6,263,987B1. When applied in deep water, the processes described become extremely expensive and slow.

Accordingly, despite the developments which pertain, the prior art still requires drilling processes for oil and gas wells which involve multilateral long-distance wells in deep water without any type of completion of the drilled well, and with the use of one single surface platform for all the wells in production, such processes being described and claimed in the present patent.

SUMMARY OF THE INVENTION

In a simplified manner, the method for the construction of an arrangement of long-distance wells for the production, transport, and exploitation of mineral deposits, the arrangement of the wells thus constructed, and a method for the construction of a pipe for the transport and storage of fluids according to the invention comprises the initial drilling of a medium-distance well. At least one other multilateral medium-distance well is drilled in the same direction as the first, and in one or more directions into the reservoir which is to be taken into production, with the aim of their ends meeting or coming close, there being no type of completion and casing for the multilateral drilled well(s). The production from the wells is effected by pressure differential, the fluid flowing from the well of greater pressure into the well of lesser pressure.

The invention also comprises the drilling of wells in series to be used as transport pipes. These wells are connected hydraulically, in such a way that the resultant distance is proportional to the number of wells drilled; i.e. infinite number of wells, infinite distance.

In addition, the present invention makes provision for the connection in series of a principal well and at least one multilateral well, in order to supplement the resultant distance and to drain distant areas of the reservoir.

The invention also makes provision for the connection of a series of two or more wells in order to increase the resultant distance and to transport gases and/or liquids between distant areas.

The invention likewise provides for arrangements of wells drilled at such long distances as may be necessary, using the technology of medium-distance wells.

The invention likewise provides for arrangements of wells drilled at long distances in which only the main well needs to be connected to the production unit.

The invention likewise provides for arrangements of wells forming a network for draining reservoirs of mineral layers.

The invention likewise provides for arrangements of long-distance wells which does away with the need to break the reservoir in order to obtain the fluids produced.

The invention additionally provides for the possibility of producing fluids via long-distance wells doing away with the use of individual items of equipment for each well, with great savings in costs and environmental protection.

The invention likewise provides for a method for the construction of pipes in series and/or in parallel, forming a network for the transport and storage of fluids produced from medium-distance wells and connected hydraulically.

The invention likewise provides for a production method for mineral layers in which the flowing of the fluid produced is effected from a well of greater pressure to a well of lesser pressure.

The invention likewise provides for a network of wells for a mineral layer in which only the principal well needs to be completed.

As can be easily verified on the basis of the considerations set forth in this text, the disadvantages determined for the prior art in the drilling of long-distance multilateral wells, such as high running costs of the multiplicity of equipment, as well as environmental corrosion, are greatly reduced or even eliminated with the method proposed by the present invention.

According to the invention, therefore, the method comprises the drilling of an initial well and a number of other multilateral directional wells, following the preliminary indications from geological studies, which allows for the formation of a network of underground channels with the aim of obtaining the best possible use of the fluids present in the reservoir.

According to a preferred embodiment of the invention, the initial well directional well.

According to another embodiment, the initial well a multidirectional well.

According to another embodiment, the initial well is a vertical well.

The flow from the reservoir is associated with the collection in production of the multilateral wells which are drilled. The production from the wells of the network is incurred by the difference in pressure, causing the flow of fluids from the wells with greater pressure in the direction of the well with lesser pressure. The flow of the fluids is interrupted by equipment installed on this lower pressure well, to a production plant located on a platform on the surface of the sea. Depending on the nature of the fluid, the equipment used may be a pump or a compressor.

The practice of the invention dispenses with the operations of completion and casing of each multilateral well, it being only necessary to install casing and

complete the well of lesser pressure which is interlinked with the production platform.

According to the concept of the invention, the operations of specific drilling, the connection of the wells, and the equipment used in the operations are those commonly used in the state of the art, and do not constitute the object of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described, by way of non-limitative example only, with reference to the accompanying schematic drawings, in which:-

FIGURE 1 shows a view of an arrangement according to the invention, with a multilateral well 2 and two drilling sections in opposite directions and of medium distance 5 and 6, the well 2 being connected hydraulically to the medium-distance well 1 by means of the drilling section 7.

FIGURE 2 shows a diagram of the exploitation of a field in deep water, using the concept according to the invention.

FIGURE 3 shows a view of an arrangement according to the invention, in which two wells of medium distance 1 and 2 are hydraulically connected to each other and to the operational units 15 and 16.

FIGURE 4 shows a view of an arrangement according to the invention for another type of construction of a pipe across wells in series, in which four wells 1, 2, 2' and 2" are hydraulically connected to each other and to the operational units 15 and 16.

FIGURE 5 shows a view from above of the prior art with the conventional choice of construction of a pipe 18 cutting through a forest 19 and a river 20.

FIGURE 6 appended hereto shows a view from above of the invention with the method of construction proposed, of four wells in series 1, 2, 2' and 2" hydraulically connected, linking the production area 21 to the terminal 22.

FIGURE 7 appended hereto shows an example of the drainage network for fluids from a layer.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

According to the usage of the invention, the term "fluid" signifies any material endowed with the capacity to flow, in the gaseous, liquid, or solid state, alone or in a mixture in any proportion. The fluid may accordingly be petroleum, gas, or even a mineral or sand.

"Formation" is a production formation, such as a formation producing petroleum or gas.

"Reservoir" is the rock of the production formation, located in the ground or sub-soil, which contains a reserve, layer, or accumulation of minerals, such as a reservoir of hydrocarbons, petroleum, and/or gas.

FIGURE 1 shows a side view of an arrangement in accordance with the invention, in which the multilateral well 2, with two drilling sections in opposite directions and of medium distance 5 and 6, are connected hydraulically to the medium-distance well 1 by means of the drilling section 7.

According to one embodiment of the invention, the offshore reservoir 3 of fluids is initially penetrated by the well 1. The multilateral well 2 is then drilled, coming close to or connecting with the end of the drilling section 5 of the well 2 at the end of the drilling section 7 of the well 1. This accordingly forms a long-distance well, connecting hydraulically the end 6 of the well 2 to the end 7 of the well 1 and to the production unit 8. The resultant long-distance well will allow for flow from the reservoir in deep and extremely deep water 10 from a platform in shallower waters 9. The well 1 can even be of dry completion.

Alternatively, according to another embodiment, a connection is established between the well 1 and the production platform unit 8 by means of a rigid production pipe arranged inside the riser or flexible line 11 of short length. The well 1 will be the production well. The head 4 of the well 2 can be simply closed off. This head 4 may possibly be used in cleaning or fishing operations, serving as a viewing aperture for inspection.

Accordingly, the initial well 1 may have its length increased by about three times, which can be determined by considering Figures 1 and 2. In these figures the medium-distance well 2 is drilled with two drilling sections in opposite directions 5 and 6, and is connected hydraulically to the initial well 1 of medium distance, the drilling section 7 of which is equivalent to each of the drilling sections 5 and 6 of the well 2. The final distance obtained is therefore the result of the sum of the distances of the three drilling sections 5, 6, and 7, corresponding to a total length of approximately three times the distance of each section of medium-distance drilling.

It can be easily understood by persons skilled in the art that it is possible, within the concept of the invention, to increase the distance of the well by more than three times by drilling one or more wells in the series 2, 2', 2", ... 2n, which will also be connected hydraulically to the initial well 1, in such a way as to increase the total distance as desired. Only the initial well 1 needs to be interlinked with the

production unit 8. In this case, the other wells 2, 2', 2", ... 2n will have the heads 4, 4',4", ... 4n closed off. This will allow for the sequence of the wells to reach very distant areas of the reservoir 3.

FIGURE 2 shows the exploitation diagram of a field in deep water, using the concept of the invention, and, in a horizontal projection, an arrangement of nine multilateral wells, 1 being the initial well and 2, 2A, 2B, 2C, ... 2G being multilateral wells corresponding to the wellheads 4, 4A, 4B, 4C, ... 4G of medium length, intended to drain the fluids produced from the field to a production unit 8. The multilateral wells 2, 2A, 2B, 2C, ... 2G may have two drilling sections in opposite directions 5 and 6, three drilling sections of oblique orientation 5, 12, and 13, or three drilling sections, two being in opposite directions 5 and 6 and one drilling section 14 of orthogonal orientation to the other two, depending on the area of the reservoir which it is intended to enclose with the drainage. An initial multilateral well 1 of medium distance and of multiple drilling sections 7, 7A, 7B, 7C, ... 7G, which connect hydraulically to the drilling sections 5, 5A, 5B, 5C, ... 5G of the multilateral wells 2, 2A, 2B, 2C, ... 2G, conducting the fluids drained from the reservoir 3 to the production unit 8 on the surface.

Still within the concept of the invention, the construction of a pipe for the transport and storage of fluids is the object of the following Figures:

FIGURE 3 shows a side view in which two medium-distance wells 1 and 2 are hydraulically connected. These wells interlink the operational units 15 and 16, and form a conventional pipe for the transport of liquids and/or gases. The underground reservoir 3 is initially penetrated by the well 1. The well 2 then penetrates it, connecting to the end of the drilling section 5 of the well 2 at the end of the drilling section 7 of the well 1. A long-distance well is accordingly formed, hydraulically connecting the well 2 to the well 1 and the production unit 8.

Alternatively, the well 2 can also be drilled in the opposite direction. The head 4 of the well 2 can be simply closed off. The head 4 of well 2 can possibly be used as a viewing opening for inspection operations or for cleaning. The pumping or compression equipment 17 promotes the transport of the fluids from the unit 15 to the unit 16. The final compression of the pipe will depend on the total number of wells drilled in series.

FIGURE 4 shows a side view of an alternative construction of a pipe across the wells in series, in which four wells 1, 2, 2' and 2" are hydraulically connected to one another and to the operational units 15 and 16.

FIGURE 5 shows the conventional option for the construction of a pipe 18 cutting through forest 19 and river 20, in which the pipe 18 linking the production area 21 with the terminal 22 is laid on the forest floor 19 or in an excavation 23 initially open. To cross the river 20, the pipe 18 will have to pass beneath the bed of the river 20, the excavation 23 of this stretch being carried out with the use of specific equipment (boring machine).

FIGURE 6 illustrates the inventive proposal of the construction of four wells in series, 1, 2, 2' and 2", connected hydraulically and linking the production area 21 to the terminal 22. The wells 1, 2, 2' and 2" are drilled with two drilling sections in opposite directions, in such a way that the drilling section of one well interlinks with the drilling section of the following well. The first well 1 will have a drilling section connected to the production area 21. In the same way, the last well 2" will have a drilling section which will connect to the terminal 22. The proposed method dispenses with the laying of any pipes or the need for specific equipment not provided for in the drilling operation.

FIGURE 7 shows a possible version of a drainage network for a reservoir with a fluid-producing layer. The network is formed by the arrangement of multilateral wells drilled in series (1, 2, 2', 2", ..., 2n, 2A, 2A', 2A", ...2An) and/or in parallel (40,

40', 40", ..., 40n, 50, 50', 50", ... 50n in relation to 2, 2', 2", ... 2n, 2A, 2A', 2A",.. 2An) and in an arrangement such as will allow for the optimisation of the drainage from the whole production area of the fluids in the mineral layer, it being possible to bring about the intersection of the wells with one another (30, 30A', 30A", ... 30n in relation to 40, 40', 40", ..., 40n and 50, 50', 50", ... 50n). The differences in the pressures between the different wells will determine the flow of the fluids being in the direction from the wells of greater pressure (2, 2', 2", ..., 2n, 30, 30', 30", ... 30n) towards the well of lower pressure 1, which becomes the production well for the layer. The other wells will have their heads sealed.

According to the concept of the invention, therefore, and as can be seen from the arrangements illustrated in FIGURES 1 to 7 appended hereto, a first reduction in costs is achieved with the elimination of the operation of fracturing the geological formation. In effect, the present concept replaces the traditional methods of fracturing the formation by the arrangement of a network of channels obtained with the medium-range wells drilled and hydraulically connected to one another.

As a further advantage, the elimination of the operation of fracturing the formation also makes it possible to gain time in taking into operation the production wells which drain the formation, so shortening the return time on the investments assigned.

Another advantage of the method is the reduction of costs achieved by both the elimination of the completion of the multilateral wells and of the use of casing and cementing of the walls of the respective wells.

By analogy, the elimination of the operation of completion of the wells will achieve an extra gain in the time taken for the commissioning of the wells drilled, so accelerating the financial return on the project.

Another advantage of a technical nature is additionally achieved by the removal of the obstacle presented by the casing of the wells against the flow of the fluids, making it possible for greater yield to be obtained from the production wells.

Equally advantageous is the reduction achieved in the investment costs, with the reduction in production equipment to the minimum necessary, represented by one single pump or compressor, by the equipment for the single wellhead, the Christmas tree, the production line, the riser, and other single items of production equipment.

Operationally, another economic advantage can likewise be achieved in the form of lower costs for maintenance services and intervention on the well, once the quantity of production equipment has been drastically reduced to the minimum necessary for production by means of one single well.

As an immediate consequence, another operational advantage is achieved with a reduction of the probable down-time for the well.

A second advantage of a technical nature is achieved by a reduction in the costs of handling the well production equipment, reduced to the minimum necessary.

In addition, a substantial saving in operational terms is also obtained thanks to the use of one single production platform for the processing of the fluids produced from the formation.

This saving becomes more evident if it is noted that the proposed process will allow for the platform to be positioned in substantially shallower water (see Figure 1), so requiring less robust equipment, which is capable of operating under less severe conditions, as well as much lower costs for planning, immobilisation, transport, operation, and handling.

A third technical advantage is to be gained in respect of the increase in productivity with the flow of fluids leaving the multilateral wells to the principal well in underground channels, which are therefore protected against the low temperatures encountered at great depths in the sea, and so minimising the problems incurred by the depositing of paraffin and the formation of hydrates, with positive effects on flow rates.

From the point of view of the environment, one of the advantages which the process provides is a reduction in the risk of leaks and environmental pollution between the main well located on the sea bed and the production platform on the surface, incurring a reduction in the number of pipes and submerged production equipment to the minimum necessary to service one single well.

From the consideration of the environment, too, if the due proportions are maintained, it will be observed that difficulties analogous to those which pertain at the laying of the pipes and the installation of other underwater production equipment will also arise when the same type of service is carried out in other severe and hostile environments, such as swamps, jungles, dense forests, or inhospitable deserts.

In the case of dense tropical forest, lakes, swamps, or rivers, the method according to the invention leads to additional gains both in terms of the environment and financially; namely, these are the avoidance of clearance or crossing of hostile environments, with possibly damaging effects on the flora, fauna, soil, and, in the final analysis, on all the other elements in the particular ecosystems pertaining to them, as well as the costs of obtaining the environmental licences from the regulatory authorities, or the obligation to undertake relocation of persons, animals, and materials which are potentially capable of being removed (timber extracted, courses and bodies of water dammed or diverted, specimens of

animals, birds, and plants to be preserved, movement of earth to be introduced or removed, and all the services associated with or inherent thereto).

Finally, advantages of a socio-economic-demographic order can also be obtained by the process according to the invention if, by its use, the crossing of pipes and installation of other equipment can be avoided in densely populated areas such as urban centres, coastal areas, tourist areas, or leisure and vacation areas, so reducing the impacts resulting from expropriations, population relocations, urban works, demolitions, traffic hold-ups involving both vehicles and pedestrians, and the exposure of the public to the potential risks of gases and vapours.

Accordingly, the present invention allows for long distances to be achieved without the need for special probes and equipment necessary for the drilling of very long-distance wells, and so only requiring equipment readily available on the market. As a consequence, the invention will have a great impact on production in deep and very deep water, since petroleum and gas wells will reach reservoirs located in very deep water from a platform which is installed in very shallow water.

The invention will also have a great impact on pipeline transport in sensitive areas as well as in densely populated areas, forests, lakes, swamps, rivers, and coastline regions close to urban or tourist centres, without forgetting the reduction in the environmental impact and the minimisation of the risk of leaks which would certainly pertain.

CLAIMS

1. A method for the construction of an arrangement of extended-reach wells for the production, transport, and exploitation of mineral layers present in a reservoir of a geological formation, said method comprising:

drilling a first well of medium distance;

then drilling at least one multilateral well, formed of two separated drilling sections, each of medium length, said multilateral well connected hydraulically to the medium-distance well by means of drilling sections, so as to form an extended-reach well by the hydraulic connection of the end of one of said drilling sections of the multilateral well to the end of a drilling section of the medium-distance well, so obtaining an extended-reach well which allows for the drainage of the reservoir in deep water and extremely deep water from a platform in shallower water.

2. A method according to claim 1, wherein said wells are drilled on the basis of indications from geological studies.

3. A method according to claim 1 or 2, wherein said two separated drilling sections of said multilateral well run in opposite directions.

4. A method according to any one of the preceding claims, wherein the mineral layers comprise fluids in the gaseous, liquid, or solid state, in isolation or in a mixture of any proportion.

5. A method according to claim 4, wherein the fluids produced comprise petroleum and gas.

6. A method according to any one of the preceding claims, wherein that the operations of completion and casing are dispensed with for the multilateral wells.

7. A method according to any one of the preceding claims, wherein the initial well is a directional well.

8. A method according to any one of the preceding claims, wherein the initial well is a multi-directional well.

9. A method according to any one of the preceding claims, wherein the initial well is a vertical well.

10. A method according to any one of the preceding claims, wherein the well is connected to a production unit platform by means of a rigid production pipe located inside a riser or flexible line of short length, the well being the production well.

11. A method according to any one of the preceding claims, wherein the final distance obtained is the result of the sum of the distances of the two drilling sections of the multilateral well and the drilling section of the medium-distance well, corresponding to a total distance of approximately three times the distance of each drilling section of medium distance.

12. A method according to any one of the preceding claims, wherein the distance of said medium-distance well is increased by more than three times by the drilling of one or more wells in a series which are each connected hydraulically to the medium-distance well, in such a way as to increase the total distance, only the medium-distance well being connected to a production unit, while the other wells have their heads closed off.

13. A method according to any one of the preceding claims, wherein there are drilled a plurality of multilateral wells, of medium distance, each provided with two drilling sections in opposite directions, the hydraulic connection of multiple drilling sections being carried out in such a way as to conduct the fluids draining from the reservoir as far as a production unit on the surface, connected to said first well.

14. A method according to any one of the preceding claims, wherein there are drilled a plurality of multilateral wells of medium length, at least one of which is provided with a first drilling section and two more drilling sections of oblique orientation, the hydraulic connection of the multiple drilling sections of said first well to the drilling sections of the multilateral wells being carried out in such a way as to conduct the fluids drained from the reservoir as far as a production unit on the surface.

15. A method according to any one of the preceding claims, wherein there are drilled a plurality of multilateral wells of medium length, each provided with three drilling sections, two being in opposite directions, and one further drilling section of orthogonal orientation in respect of the other two, wherein drainage as far as a production unit is effected by the hydraulic connection of the multiple drilling sections of said first well to the drilling sections of the multilateral wells, in such a way as to conduct the fluids drained from the reservoir as far as the production unit on the surface.

16. A method according to any one of the preceding claims, wherein, for the transport of the fluids produced, two wells of medium length hydraulically connect two operational units in the manner of a conventional pipe for the transport of liquids and/or gases.

17. A method according to claim 16, wherein, for the transport of the fluids produced, the underground reservoir is initially penetrated by the first well, then penetrated by the multilateral well, the end of the drilling section of said first well is connected to the end of the drilling section of said multilateral well, thereby forming one long-distance well, the end of the drilling section of the multilateral well is hydraulically connected to the end of the drilling section of said first well and to the production unit.

18. A method according to any one of the preceding claims, wherein the fluids produced from the production layers are recovered with the aid of a drainage network.

19. A method according to claim 18, wherein the drainage network is formed by an arrangement of multilateral wells drilled in series and in an arrangement such as will allow for the optimization of the drainage of the whole fluids production area of the mineral layer, the difference between the pressures of the various different wells determining that the flow of the fluids will be in the direction from the wells of greater pressure to the first well of lesser pressure, which will become the production well for the layer, the other wells having their heads closed off.

20. A method according to claim 18, wherein the drainage network is formed by an arrangement of multilateral wells drilled in parallel and in an arrangement such as will allow for the optimization of the drainage of the whole fluids production area of the mineral layer, the difference between the pressures of the various different wells determining that the flow of the fluids produced will be in the direction from the wells of greater pressure to the first well of lesser pressure, which will become the production well for the layer, the other wells having their heads closed off.

21. A method according to claim 18, wherein the drainage network is formed by an arrangement of wells, drilled with the wells intersecting one another, the difference between the pressures of the various different wells determining that the flow of the fluids produced will be in the direction from the wells of greater pressure to the first well of lesser pressure, which will become the production well for the layer, the other wells having their heads closed off.

22. A method according to claim 21, wherein the arrangement of wells of the drainage network comprises vertical, directional, and multilateral wells.

23. An arrangement of extended-reach wells for the production and transport of fluids, and exploitation of mineral layers present in a geological formation, comprising an initial drilled well and at least one other multilateral well, forming a network of underground channels from which the flow of fluids takes place in the direction from the wells of greater pressure to the well of lesser pressure.

24. An arrangement in accordance with claim 23, comprising a first well of medium distance and at least one multilateral well provided with two drilling sections in opposite directions and of medium distance, said multilateral well being connected hydraulically to the well of medium distance by means of a first drilling section, forming a well of long distance by the hydraulic connection of the second drilling section of said multilateral well to the end of said first well and to a production unit.

25. An arrangement in accordance with claim 23 or 24, wherein long distances are obtained by one or more wells in series, which are also connected hydraulically to the initial well, said initial well being the only one connected to the production unit, while the other wells have their heads closed off.

26. An arrangement in accordance with claim 23, 24 or 25, which allows for the drainage of the multilateral wells of medium length, each provided with two drilling sections in opposite directions, as far as a production unit, by the hydraulic connection of multiple drilling sections of the initial well with the drilling sections of the multilateral wells in such a way as to conduct the fluids drained from the reservoir as far as a production unit on the surface.

27. An arrangement in accordance with any one of claims 23 to 26, which allows for the drainage of the multilateral wells of medium length, each provided with three drilling sections, two of these drilling sections being of oblique orientation in relation to the other drilling sections as far as a production unit, by the hydraulic connection of multiple drilling sections of the initial well with the

drilling sections of the multilateral wells in such a way as to conduct the fluids drained from the reservoir as far as a production unit on the surface.

28. An arrangement in accordance with any one of claims 23 to 27, which allows for the drainage of the multilateral wells of medium length, each provided with three drilling sections, being in opposite directions respectively, two of said drilling sections being of orthogonal orientation in respect to the third drilling section, as far as a production unit, by the hydraulic connection of multiple drilling sections of the initial well with the drilling sections of the multilateral wells in such a way as to conduct the fluids drained from the reservoir as far as a production unit on the surface.

29. An arrangement in accordance with any one of claims 23 to 28, which forms a drainage network for the flow of the fluids produced from the formation.

30. An arrangement in accordance with claim 29, wherein the drainage network is formed by an arrangement of multilateral wells drilled in series, and in an arrangement such as will allow for the optimization of the drainage of the whole fluids production area of the mineral layer, the difference between the pressures of the various different wells determining that the flow of the fluids produced will be in the direction from the wells of greater pressure to the well of lesser pressure, which will become the production well for the layer, the other wells having their heads closed off.

31. An arrangement in accordance with claim 29, wherein the drainage network is formed by an arrangement of wells drilled in parallel in relation to the multilateral wells and an arrangement such as will allow for the optimization of the drainage of the whole fluids production area of the mineral layer, the difference between the pressures of the various different wells determining that the flow of the fluids produced will be in the direction from the wells of greater pressure to the well of

lesser pressure, which will become the production well for the layer, the other wells having their heads closed off.

32. An arrangement in accordance with claim 29, characterised in that the drainage network is formed by an arrangement of wells drilled with the wells intersecting one another, the difference between the pressures of the various different wells determining that the flow of the fluids produced will be in the direction from the wells of greater pressure to the well of lesser pressure, which will become the production well for the layer, the other wells having their heads closed off.

33. An arrangement in accordance with claim 32, wherein the arrangement of wells in the drainage network comprises vertical, directional, and multilateral wells.

34. An arrangement in accordance with any one of claims 23 to 33, wherein the long-distance wells do away with the need for fracturing the reservoir in order to obtain the fluids produced.

35. A method for the construction of a network of pipes for the transport and storage of fluids produced from mineral layers present in an underground reservoir said method comprising:

drilling one single pipe into the underground reservoir;

using two wells of medium distance which are hydraulically connected, said wells being connected to two operational units in the manner of a conventional pipe for the transport of liquids and/or gases.

36. Method for the construction of a network of pipes in accordance with claim 35, wherein storage is carried out in a network of pipes constructed in accordance with an arrangement of multilateral wells drilled in series, said network being connected hydraulically by means of at least two wells of medium distance to at least two operational units, the other wells having their heads closed off.

37. A method for the construction of a network of pipes in accordance with claim 35 or 36, wherein storage is carried out in a network of pipes constructed in accordance with an arrangement of multilateral wells drilled in parallel, said network being connected hydraulically by means of at least two wells of medium distance to at least two operational units, the other wells having their heads closed off.

38. A method in accordance with any one of claims 35 to 37, wherein storage is carried out in a network of pipes constructed in accordance with an arrangement of wells drilled with intersection of the wells with one another, said network being connected hydraulically by means of at least two wells of medium distance to at least two operational units, the other wells having their heads closed off.

39. A method in accordance with claim 38, wherein the arrangement of wells constructed in the network of pipes for storage comprises vertical, directional, and multilateral wells.

40. An arrangement in accordance with any one of claims 23 to 34, wherein a storage network is formed for the fluids produced from the formation.

41. An arrangement in accordance with claim 40, wherein the storage network is formed by an arrangement of multilateral wells drilled in series said network being connected hydraulically by means of at least two wells of medium distance to at least two operational units, the other wells having their heads closed off.

42. An arrangement in accordance with claim 40 or 41, wherein the storage network is formed by an arrangement of multilateral wells drilled in parallel, said network being connected hydraulically by means of at least two wells of medium

distance to at least two operational units, the other wells having their heads closed off.

43. An arrangement in accordance with claim 40, 41 or 42, wherein the storage network is formed by an arrangement of wells drilled with intersection of the wells with one another, said network being connected hydraulically by means of at least two wells of medium distance to at least two operational units, the other wells having their heads closed off.

44. An arrangement in accordance with claim 43, wherein the arrangement of wells in the storage network comprises vertical, directional, and multilateral wells.

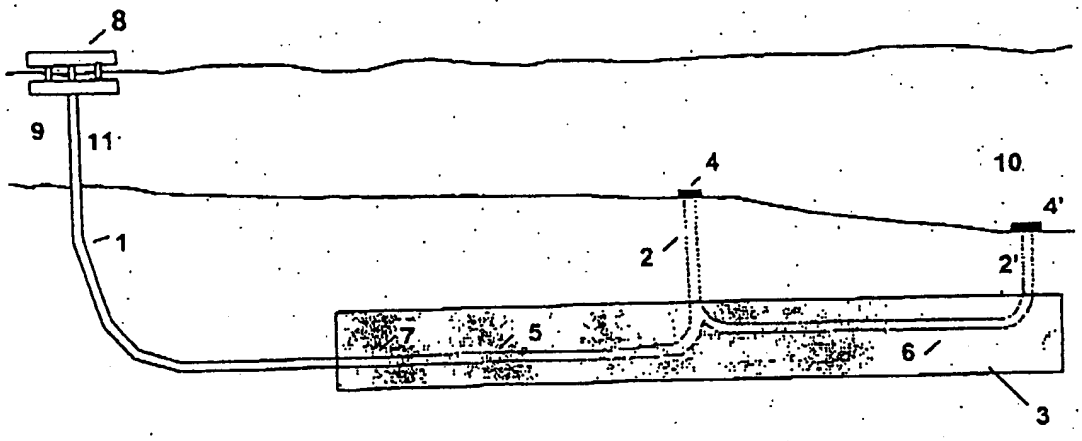


FIGURA 1

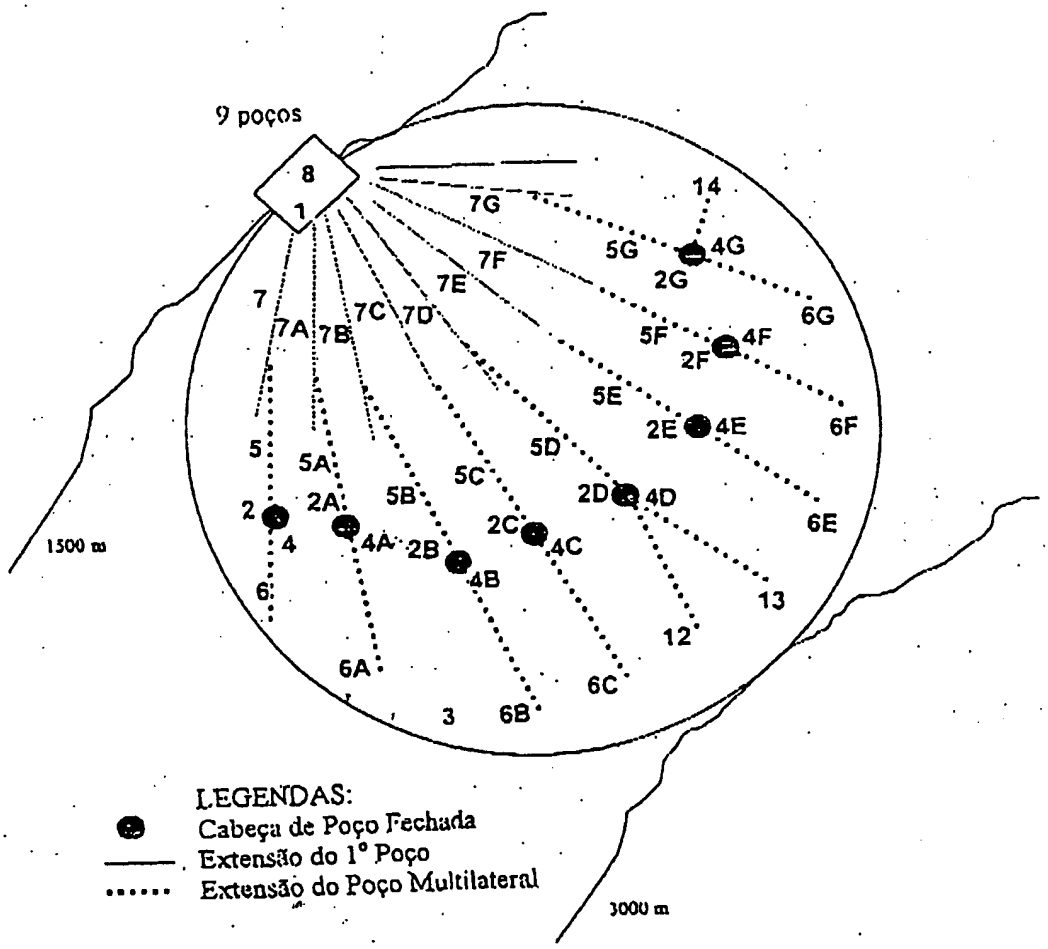

9 poços
8
1
7G
14
5G
4G
2G
7F
7E
6G
7
7A
7B
7C
7D
5F
4F
2F
5E
2E
4E
6F
5
5A
5D
5C
2D
4D
2
2A
5B
2C
4C
6E
1500 m
4
4A
2B
4B
6
13
12
6A
6C
3
6B
LEGENDAS:
Cabeça de Poço Fechada
Extensão do 1° Poço
Extensão do Poço Multilateral
3000 m

FIGURA 2

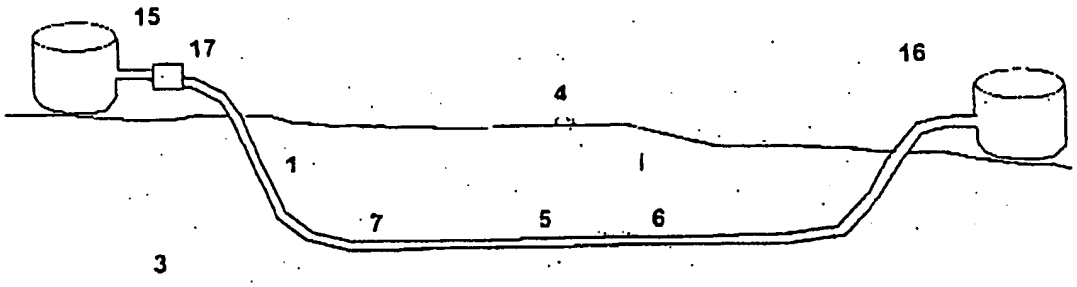


FIGURA 3

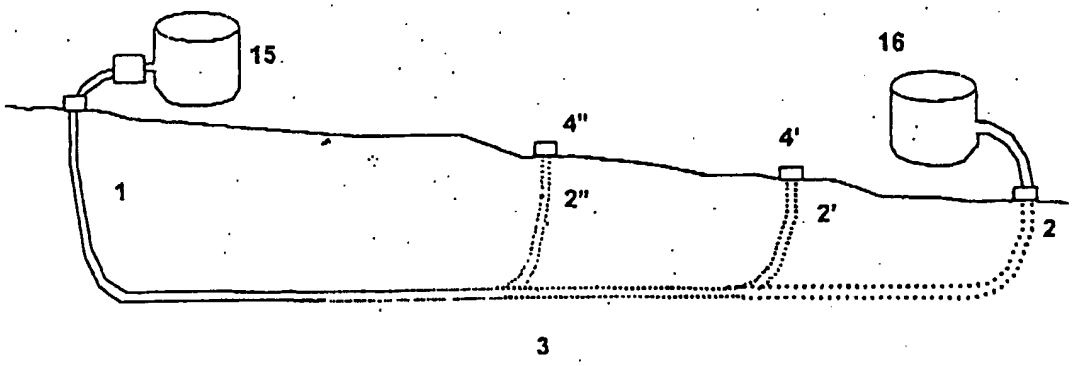
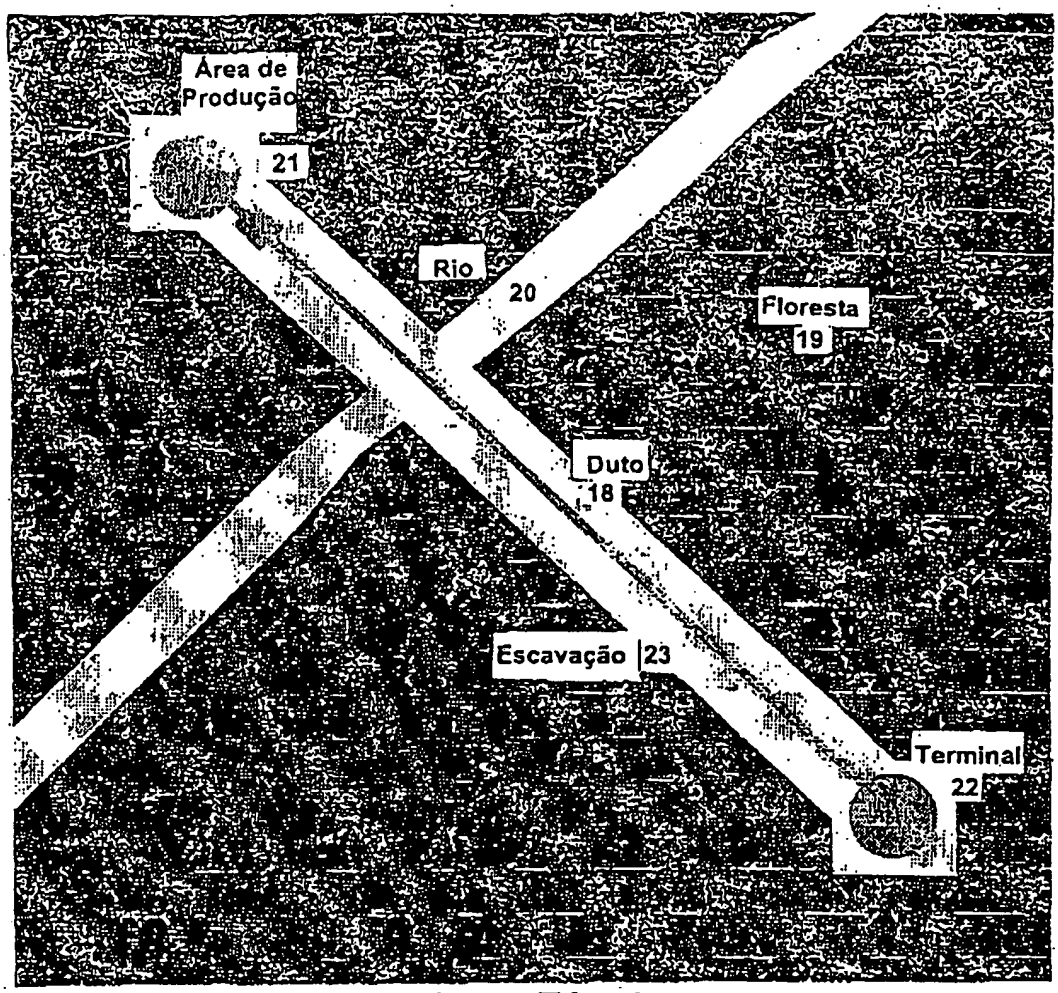
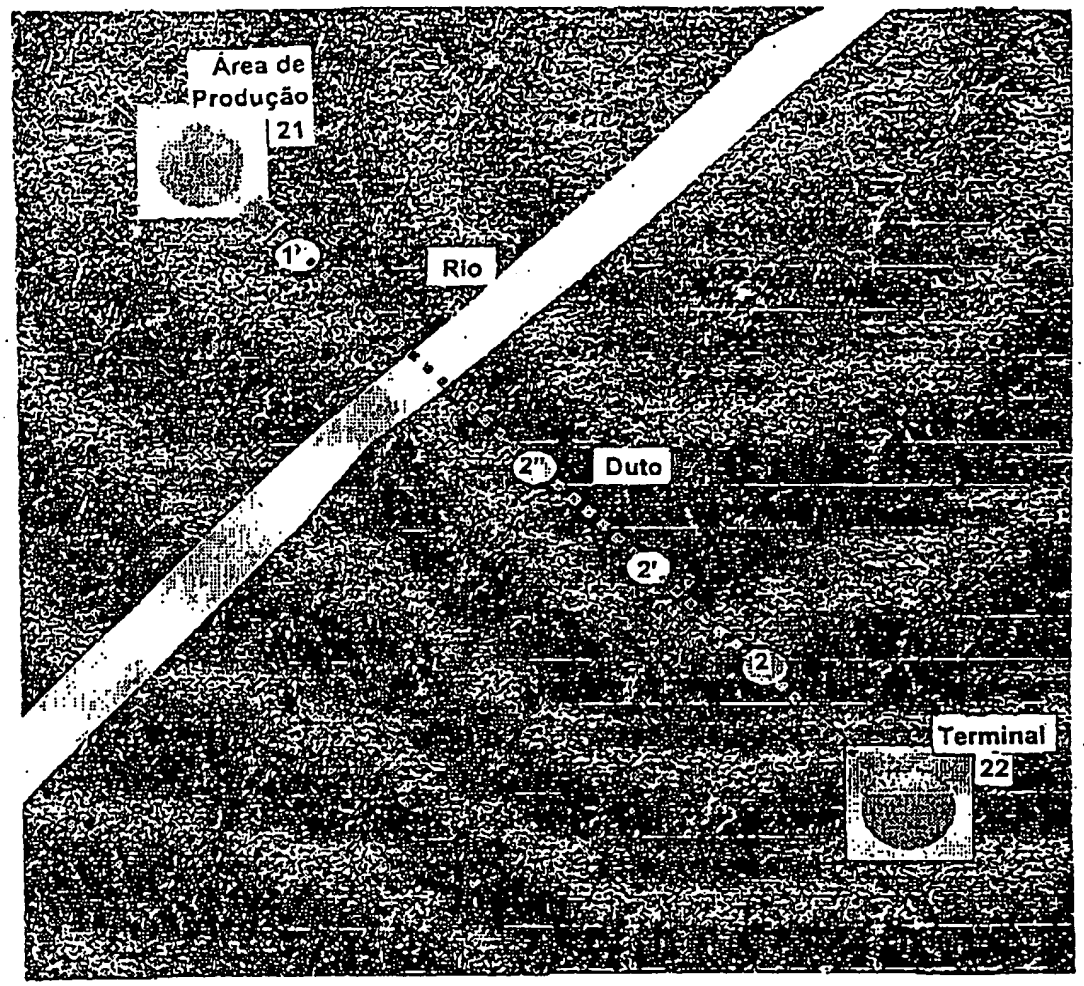


FIGURA 4



Estado da Técnica

FIGURA 5



Invenção

FIGURA 6

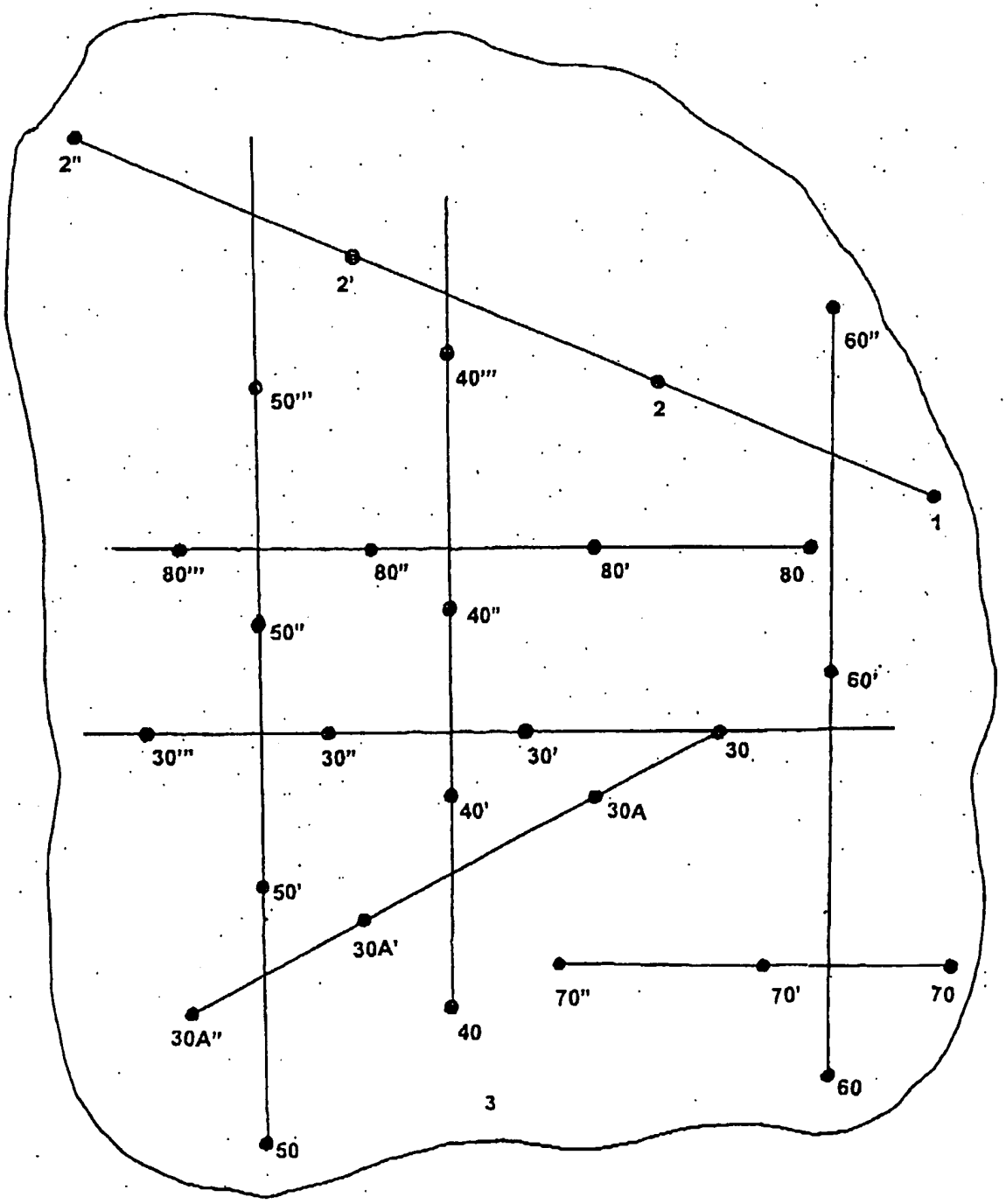

2"
2'
2
1
60"
50'''
40'''
80'''
80"
80'
80
50"
40"
60'
30'''
30"
30'
30
40'
30A
50'
30A'
70"
70'
70
30A"
40
60
3
50

FIGURA 7

INTERNATIONAL SEARCH REPORT

Intern Application No
PCT/GB 03/02809

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B41/00 E21B43/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 875 661 A (SHELL INT RESEARCH) 4 November 1998 (1998-11-04) the whole document	1-5, 7-12,23, 35
Y	US 5 016 709 A (COMBE JEAN ET AL) 21 May 1991 (1991-05-21) abstract; figure 1	1-6,35
A	the whole document	1,23
Y	CUNHA, J C ET AL: "Planning extended reach wells for deep water" SPE INTERNATIONAL PETROLEUM CONFERENCE AND EXHIBITION, 10 - 12 February 2002, XP009026526 Villahermosa, Mexico the whole document	1-6

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 March 2004	08/03/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Morrish, S

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intern | Application No
PCT/GB 03/02809

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6 280 000 B1 (ZUPANICK JOSEPH A) 28 August 2001 (2001-08-28) page 2, line 29 -page 3, line 33; figure 1	35
A	US 4 705 431 A (PETIT HERVE ET AL) 10 November 1987 (1987-11-10) abstract; figures 5,6	1,23,35
A	US 4 390 067 A (WILLMAN BERTRAM T) 28 June 1983 (1983-06-28) abstract; figures 1A,1B	1,23,35
A	WO 94 21889 A (NORTH JOHN) 29 September 1994 (1994-09-29) abstract; figures 1-14B	1,23,35
A	"STATOIL DRILLS WORLD RECORD EXTENDED-REACH WELL" PETROLEUM ENGINEER INTERNATIONAL, HART PUBLICATIONS, US, vol. 64, no. 3, 1 March 1992 (1992-03-01), pages 25-28, XP000268847 ISSN: 0164-8322 the whole document	1,23,35

INTERNATIONAL SEARCH REPORT

ıation on patent family members

Interna Application No
PCT/GB 03/02809

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0875661	A	04-11-1998	EP	0875661 A1	04-11-1998
			AU	730212 B2	01-03-2001
			AU	7760798 A	24-11-1998
			CN	1252851 T	10-05-2000
			EA	922 B1	26-06-2000
			EG	21404 A	31-10-2001
			WO	9849424 A1	05-11-1998
			EP	0980463 A1	23-02-2000
			ID	22927 A	16-12-1999
			NO	995247 A	17-11-1999
US 5016709	A	21-05-1991	FR	2632350 A1	08-12-1989
			CA	1332147 C	27-09-1994
US 6280000	B1	28-08-2001	AU	760896 B2	22-05-2003
			AU	3101800 A	13-06-2000
			CA	2350504 A1	02-06-2000
			CA	2441667 A1	02-06-2000
			CA	2441671 A1	02-06-2000
			CA	2441672 A1	02-06-2000
			CA	2447254 A1	02-06-2000
			CN	1333858 T	30-01-2002
			CZ	20011757 A3	12-02-2003
			EP	1316673 A2	04-06-2003
			EP	1131535 A2	12-09-2001
			ID	30391 A	29-11-2001
			NZ	512303 A	29-08-2003
			NZ	527146 A	28-11-2003
			NZ	528538 A	28-11-2003
			PL	348705 A1	03-06-2002
			US	2002096336 A1	25-07-2002
			WO	0031376 A2	02-06-2000
			US	2002117297 A1	29-08-2002
			US	2002108746 A1	15-08-2002
			US	2002148613 A1	17-10-2002
			US	2002148605 A1	17-10-2002
			US	6679322 B1	20-01-2004
			US	6357523 B1	19-03-2002
			US	6598686 B1	29-07-2003
			US	2002148647 A1	17-10-2002
			US	2001015574 A1	23-08-2001
			US	2001010432 A1	02-08-2001
			US	2002134546 A1	26-09-2002
			ZA	200103917 A	14-01-2002
US 4705431	A	10-11-1987	FR	2557195 A1	28-06-1985
			BR	8406663 A	22-10-1985
			CA	1297785 C	24-03-1992
			GB	2151674 A ,B	24-07-1985
			IN	162606 A1	18-06-1988
			MX	171706 B	10-11-1993
			NO	845173 A	24-06-1985
US 4390067	A	28-06-1983	CA	1167373 A1	15-05-1984
WO 9421889	A	29-09-1994	AU	6214794 A	11-10-1994
			CA	2158637 A1	29-09-1994
			WO	9421889 A2	29-09-1994